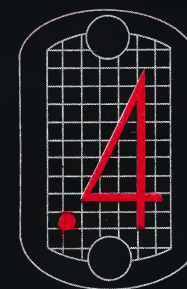
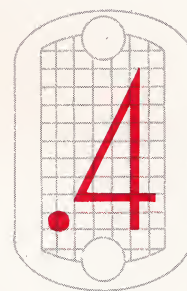


NATIONAL ELECTRONICS, INC. **READOUT TUBES**



NATIONAL ELECTRONICS, INC.

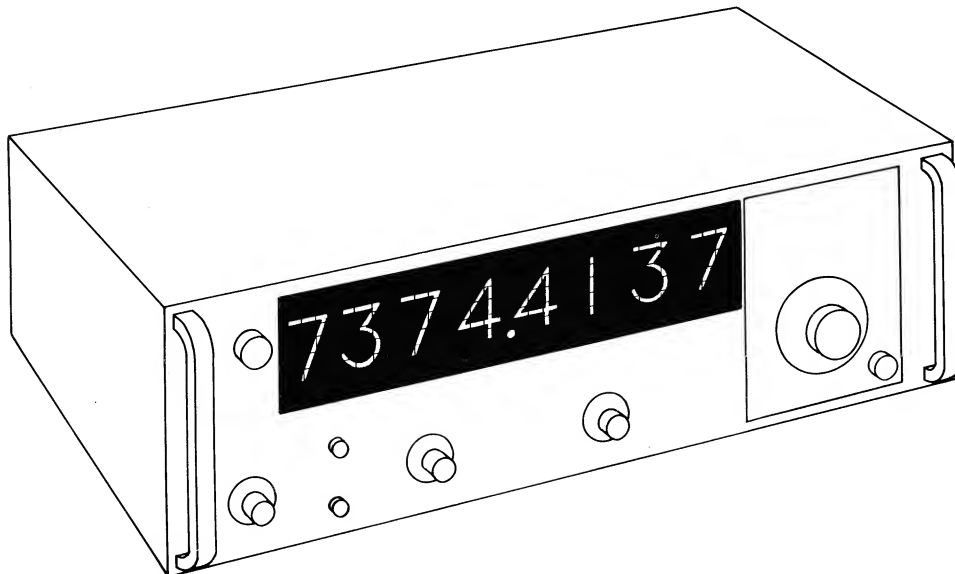
A SUBSIDIARY OF VARIAN ASSOCIATES

GENEVA, ILLINOIS

(312) 232-4300

***READOUT TUBES BY NATIONAL ELECTRONICS, INC.**

NATIONAL® READOUT TUBES are simple neon filled cold cathode discharge tubes. Each tube consists of a common anode and 10 independent cathodes, each formed in the shape of a numeral. Application of a negative voltage to a selected cathode causes the gas around the cathode to ionize and glow. The visual effect is a bright red orange neon glow closely following the shape of the energized cathode.



NATIONAL® READOUT TUBES — electronic display devices that are

MODERN — all electronic, low power, high speed.

RUGGED — longest life of any Readout; shock and vibration meet military requirements.

ATTRACTIVE — well shaped characters, bright even color.

ECONOMICAL — Lowest initial cost, lower operating costs.

WARRANTY

LONG LIFE READOUT tubes are warranted to be free from defects caused by materials, workmanship, and construction for a period of two years from the date of shipment. Standard Life readout tubes are warranted to be free from defects caused by materials, workmanship and construction for a period of 90 days from date of shipment. National Electronics, Inc. liability under this warranty is limited to replacing or repairing any tube returned by the buyer during such period provided:

1. Buyer promptly notifies National Electronics, Inc., Geneva, Illinois in writing requesting authorization to return the tube as per our warranty policy. Letters should itemize complaints.
2. The defective unit is returned to address in (1), transportation charges prepaid.
3. Manufacturer's examination shall disclose to its satisfaction that defects have not been caused by misuse, neglect, accident or improper installation.

Under no conditions shall National Electronics, Inc. be liable for collateral or consequential damages. The warranty is in lieu of all other warranties expressed or implied.

* Manufactured under license from Burroughs Corporation.

SELECTION GUIDE

NATIONAL ELECTRONICS READOUT TUBES

MINIATURE
 .310 CHARACTER SIZE
 14' VIEWING DISTANCE



NL7977/4032
LONG LIFE



NL7009
REGULAR LIFE



NL8502/4021
REGULAR LIFE
LOW VOLTAGE



NL6844A
REGULAR LIFE



NL8421/5092
LONG LIFE
WIDE ANGLE



NL8422/5991
LONG LIFE
RECTANGULAR



NL809
LONG LIFE
RECTANGULAR
WITH DECIMAL POINT

STANDARD
 END VIEWING
 .610 CHARACTER SIZE
 30' VIEWING DISTANCE



NL803
LONG LIFE



NL812
LONG LIFE
WITH DECIMAL POINT

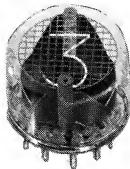


NL5030
LONG LIFE
BIQUINARY

STANDARD
 SIDE VIEWING
 .610 CHARACTER SIZE
 30' VIEWING DISTANCE



NL7153
REGULAR LIFE



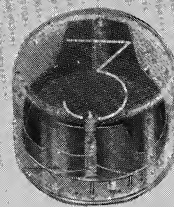
NL8423/6091
LONG LIFE
WIDE ANGLE



NL807
SIDE VIEWING
LONG LIFE

SUPER SIDE
 SIDE AND END VIEWING
 .808 CHARACTER SIZE
 38' VIEWING DISTANCE

LARGE AND JUMBO
 SIDE AND END VIEWING
 CHARACTER SIZE 1.375" and 2"
 VIEWING DISTANCE 65' and 100'



NL8091
LARGE LONG LIFE
WIDE ANGLE



NL7094
JUMBO LONG LIFE
WIDE ANGLE



NL7037
JUMBO LONG LIFE
SIDE VIEWING

LONG LIFE READOUT TUBES ARE WARRANTED FOR 2 YEARS. NORMAL EXPECTED LIFE IS GREATER THAN 200,000 HOURS.


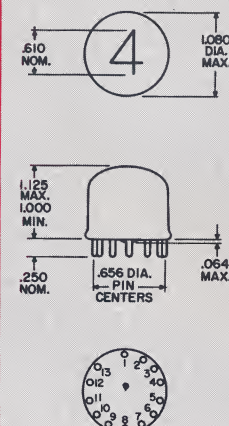
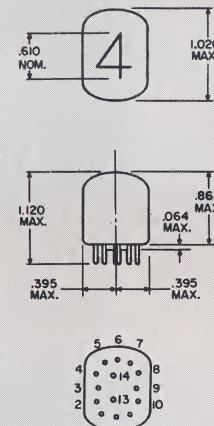
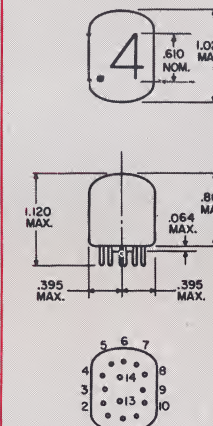
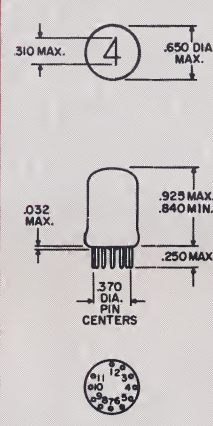
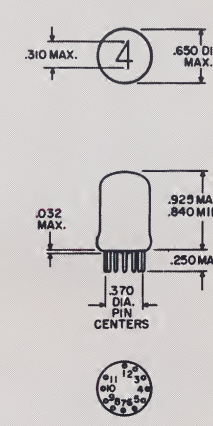
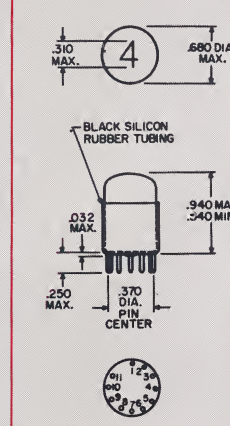
*Multiple type numbers are always the EIA assigned number followed by the common industry number.

*NUMERALS 0 thru 9	NL-7094	NL-8091	NL-8423/6091	NL-7153	NL-6844A	NL-8091																																																																																												
SYMBOLS + and -			NL-6034	NL-6012	NL-5016	NL-5091																																																																																												
CHARACTER SIZE																																																																																																		
ELECTRICAL RATINGS AND CHARACTERISTICS																																																																																																		
Ionization Voltage (Maximum)	300 Vdc	170 Vdc	170 Vdc	250 Vdc	170 Vdc	170 Vdc																																																																																												
Supply Voltage (Minimum)	300 Vdc	170 Vdc	170 Vdc	250 Vdc	170 Vdc	170 Vdc																																																																																												
Cathode Current — Peak (Max.)	7.5 ma	6.5 ma	4.5 ma	5.0 ma	4.0 ma	3.5 ma																																																																																												
Average (Max.)	7.0 ma	6.0 ma	4.0 ma	3.0 ma	3.0 ma	3.0 ma																																																																																												
Average (Min.)	4.0 ma	3.0 ma	1.5 ma	2.0 ma	1.5 ma	1.5 ma																																																																																												
dc Prebias Voltage Limits	65V to 120V	65V to 120V	65V to 120V	65V to 120V	50V to 120V	50V to 120V																																																																																												
**Recommended Operating Conditions dc Supply Voltage (Ebb)	300V	170V 250V 300V	170V 250V 300V	250V 300V	170V 250V 300V	170V 250V 300V																																																																																												
Corresponding Anode Resistor (RA)	27K	5.6K 22K 33K	6.8K 36K 56K	43K 62K	15K 51K 75K	10K 33K 56K																																																																																												
Temperature Limits	-65°C to +85°C	-65°C to +85°C	-65°C to +85°C	-65°C to +85°C	-65°C to +85°C	-65°C to +85°C																																																																																												
Weight	4 oz.	1.7 oz	0.6 oz	0.6 oz	0.4 oz	0.4 oz																																																																																												
OUTLINE DRAWINGS																																																																																																		
Socket (See Page 11)	RTS-5	RTS-5	RTS-1, RTS-2 RTS-6, RTS-8, RTS-9																																																																																															
Mounting Position	PINS 1 & 10 VERTICALLY ALIGNED WITH PIN 10 ON TOP		PINS 1-8 VERTICALLY ALIGNED WITH PIN 8 ON TOP.		PINS 1 & 8																																																																																													
PIN CONNECTIONS	<table><tr><th>PIN NUMBER</th><th>CHARACTER</th></tr><tr><td>1</td><td>Internal Conn.</td></tr><tr><td>2</td><td>Anode</td></tr><tr><td>3</td><td>0</td></tr><tr><td>4</td><td>9</td></tr><tr><td>5</td><td>Internal Conn.</td></tr><tr><td>6</td><td>Internal Conn.</td></tr><tr><td>7</td><td>8</td></tr><tr><td>8</td><td>7</td></tr><tr><td>9</td><td>6</td></tr><tr><td>10</td><td>Internal Conn.</td></tr><tr><td>11</td><td>Internal Conn.</td></tr><tr><td>12</td><td>5</td></tr><tr><td>13</td><td>4</td></tr><tr><td>14</td><td>3</td></tr><tr><td>15</td><td>Internal Conn.</td></tr><tr><td>16</td><td>2</td></tr><tr><td>17</td><td>1</td></tr></table>		PIN NUMBER	CHARACTER	1	Internal Conn.	2	Anode	3	0	4	9	5	Internal Conn.	6	Internal Conn.	7	8	8	7	9	6	10	Internal Conn.	11	Internal Conn.	12	5	13	4	14	3	15	Internal Conn.	16	2	17	1	<table><tr><th>PIN NUMBER</th><th>CHARACTER</th></tr><tr><td>1</td><td>Internal Conn.</td></tr><tr><td>2</td><td>Anode</td></tr><tr><td>3</td><td>0</td></tr><tr><td>4</td><td>9</td></tr><tr><td>5</td><td>8</td></tr><tr><td>6</td><td>7</td></tr><tr><td>7</td><td>6</td></tr><tr><td>8</td><td>Internal Conn.</td></tr><tr><td>9</td><td>5</td></tr><tr><td>10</td><td>4</td></tr><tr><td>11</td><td>3</td></tr><tr><td>12</td><td>2</td></tr><tr><td>13</td><td>1</td></tr></table>		PIN NUMBER	CHARACTER	1	Internal Conn.	2	Anode	3	0	4	9	5	8	6	7	7	6	8	Internal Conn.	9	5	10	4	11	3	12	2	13	1	<table><tr><th>PIN NUMBER</th><th>CHARACTER</th></tr><tr><td>1</td><td>Internal Conn.</td></tr><tr><td>2</td><td>Anode</td></tr><tr><td>3</td><td>0</td></tr><tr><td>4</td><td>9</td></tr><tr><td>5</td><td>8</td></tr><tr><td>6</td><td>7</td></tr><tr><td>7</td><td>6</td></tr><tr><td>8</td><td>Internal Conn.</td></tr><tr><td>9</td><td>5</td></tr><tr><td>10</td><td>4</td></tr><tr><td>11</td><td>3</td></tr><tr><td>12</td><td>2</td></tr><tr><td>13</td><td>1</td></tr></table>		PIN NUMBER	CHARACTER	1	Internal Conn.	2	Anode	3	0	4	9	5	8	6	7	7	6	8	Internal Conn.	9	5	10	4	11	3	12	2	13	1
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*Other characters available by special order

**See Fig. 1 & 3, Page 7. Use of the highest voltage available with the appropriate resistor is recommended.

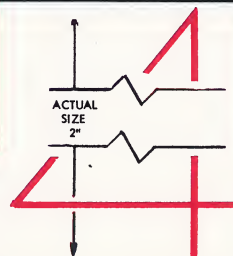
ELECTRONICS READOUT TUBES

7/5031 037	NL-8421/5092 NL-50911	NL-8422/5991 NL-5992	NL-809	NL-7009	NL-8502/4021	NL-7977/4032 NL-4031																																																																																																											
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Vdc Vdc ma ma ma	170 Vdc 170 Vdc 3.5 ma 3.0 ma 1.5 ma	170 Vdc 170 Vdc 3.5 ma 3.0 ma 1.5 ma	170 Vdc 170 Vdc 3.5 ma 3.0 ma 1.5 ma	170 Vdc 170 Vdc 2.0 ma 1.2 ma 0.7 ma	120 Vdc 120 Vdc 2.0 ma 1.4 ma 0.7 ma	170 Vdc 170 Vdc 2.0 ma 1.4 ma 0.7 ma																																																																																																											
120V	50V to 120V	50V to 120V	50V to 120V	50V to 75V	50V to 75V	50V to 120V																																																																																																											
V 300V K 68K	170V 250V 300V 10K 47K 68K	170V 250V 300V 8.2K 47K 68K	170V 250V 300V 8.2K 47K 68K	170V 250V 300V 68K 150K 200K	120V 20K	170V 250V 300V 15K 91K 150K																																																																																																											
+85°C	-65°C to +85°C	-65°C to +85°C	-65°C to +85°C	-65°C to +85°C	-65°C to +85°C	-65°C to +85°C																																																																																																											
oz	0.4 oz	0.3 oz	0.3 oz	0.14 oz	0.14 oz	0.14 oz																																																																																																											
																																																																																																																	
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VERTICALLY ALIGNED WITH PIN 8 ON TOP.	PINS 6 & 12 VERTICALLY ALIGNED WITH PIN 6 ON TOP	PINS 6 & 12 VERTICALLY ALIGNED WITH PIN 6 ON TOP	PINS 1 & 7 VERTICALLY ALIGNED WITH PIN 7 ON TOP.																																																																																																														
<table><tr><th>PIN NUMBER</th><th>CHARACTER</th><th>NL-5992 ONLY</th></tr><tr><td>1</td><td>Anode</td><td>Anode</td></tr><tr><td>2</td><td>0</td><td></td></tr><tr><td>3</td><td>9</td><td></td></tr><tr><td>4</td><td>8</td><td></td></tr><tr><td>5</td><td>7</td><td></td></tr><tr><td>6</td><td>6</td><td>Plus</td></tr><tr><td>7</td><td>5</td><td></td></tr><tr><td>8</td><td>4</td><td>Minus</td></tr><tr><td>9</td><td>3</td><td></td></tr><tr><td>10</td><td>2</td><td></td></tr><tr><td>11</td><td>1</td><td></td></tr><tr><td>12</td><td>Internal Conn.</td><td></td></tr><tr><td>13</td><td>Internal Conn.</td><td></td></tr><tr><td>14</td><td>Internal Conn.</td><td></td></tr></table>	PIN NUMBER	CHARACTER	NL-5992 ONLY	1	Anode	Anode	2	0		3	9		4	8		5	7		6	6	Plus	7	5		8	4	Minus	9	3		10	2		11	1		12	Internal Conn.		13	Internal Conn.		14	Internal Conn.		<table><tr><th>PIN NUMBER</th><th>CHARACTER</th></tr><tr><td>1</td><td>Anode</td></tr><tr><td>2</td><td>0</td></tr><tr><td>3</td><td>9</td></tr><tr><td>4</td><td>8</td></tr><tr><td>5</td><td>7</td></tr><tr><td>6</td><td>6</td></tr><tr><td>7</td><td>5</td></tr><tr><td>8</td><td>4</td></tr><tr><td>9</td><td>3</td></tr><tr><td>10</td><td>2</td></tr><tr><td>11</td><td>1</td></tr><tr><td>12</td><td>Decimal Point</td></tr><tr><td>13</td><td>Internal Conn.</td></tr><tr><td>14</td><td>Internal Conn.</td></tr></table>	PIN NUMBER	CHARACTER	1	Anode	2	0	3	9	4	8	5	7	6	6	7	5	8	4	9	3	10	2	11	1	12	Decimal Point	13	Internal Conn.	14	Internal Conn.	<table><tr><th>PIN NUMBER</th><th>CHARACTER</th><th>NL-4031 ONLY</th></tr><tr><td>1</td><td>1</td><td></td></tr><tr><td>2</td><td>2</td><td></td></tr><tr><td>3</td><td>3</td><td></td></tr><tr><td>4</td><td>4</td><td></td></tr><tr><td>5</td><td>5</td><td></td></tr><tr><td>6</td><td>6</td><td>Plus</td></tr><tr><td>7</td><td>7</td><td></td></tr><tr><td>8</td><td>8</td><td></td></tr><tr><td>9</td><td>9</td><td>Minus</td></tr><tr><td>10</td><td>0</td><td></td></tr><tr><td>11</td><td>Anode</td><td>Anode</td></tr></table>	PIN NUMBER	CHARACTER	NL-4031 ONLY	1	1		2	2		3	3		4	4		5	5		6	6	Plus	7	7		8	8		9	9	Minus	10	0		11	Anode	Anode
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TECHNICAL DATA NATIONAL ELECTRONICS READOUT TUBES

SIDEVIEWING

CHARACTER SIZE



4

4

.4

4

ELECTRICAL RATINGS

AND CHARACTERISTICS

Ionization Voltage (Maximum) 250 Vdc
Supply Voltage (Minimum) 250 Vdc
Cathode Current — Peak (Max.) 10 ma
Average (Max.) 10 ma
Average (Min.) 6 ma

250 Vdc
250 Vdc
10 ma
10 ma
6 ma

170 Vdc
170 Vdc
5.0 ma
4.5 ma
2.0 ma

170 Vdc
170 Vdc
3.5 ma
3.0 ma
1.5 ma

170 Vdc
170 Vdc
3.5 ma
3.0 ma
1.5 ma

160 Vdc
160 Vdc
4.0 ma
4.0 ma
2.0 ma

dc Prebias Voltage Limits

65V to 120V

50V to 120V

50V to 120V

50V to 120V

40V to 120V

**Recommended Operating Conditions dc Supply Voltage (Ebb)

250V 300V 350V

170V 250V 300V

170V 250V 300V

170V 250V 300V

180V 250V 300V

Corresponding Anode Resistor (RA)

12K 19K 25K

6.8K 31K 46K

8.2K 47K 68K

8.2K 47K 68K

10K 27K 39K

Temperature Limits

-65°C to +85°C

-65°C to +85°C

-65°C to +85°C

-65°C to +85°C

-55°C to +70°C

Weight

3 oz

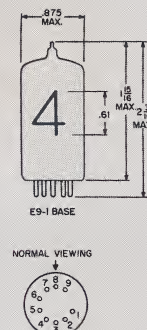
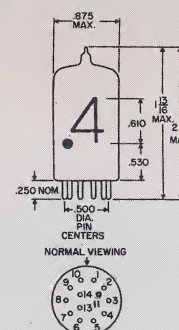
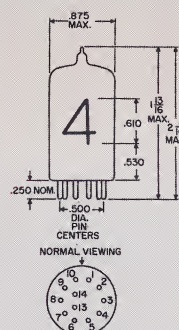
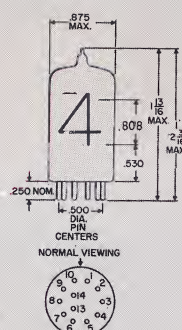
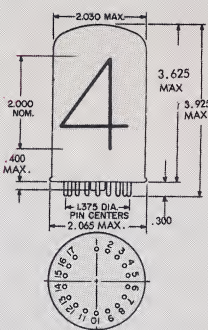
0.6 oz

0.5 oz

0.5 oz

0.5 oz

OUTLINE DRAWINGS



Socket
(See Page 11)

RTS-5

RTS-11

9 PIN MINIATURE

Mounting Position

PINS 1 & 10 ALIGNED VIEWING DIRECTION WITH PIN 1 IN FRONT

PINS 1 & 10 IN FRONT.

PINS 8 & 3 ALIGNED VIEWING DIRECTION WITH PIN 8 IN FRONT

PIN CONNECTIONS

PIN NUMBER	CHARACTER
1	Internal Conn.
2	Anode
3	6
4	0
5	Internal Conn.
6	Internal Conn.
7	2
8	4
9	1
10	Internal Conn.
11	Internal Conn.
12	8
13	9
14	5
15	Internal Conn.
16	7
17	3

PIN NUMBER	CHARACTER	NL-811 ONLY
1	7	
2	5	
3	8	
4	Anode	Anode
5	1	
6	4	Plus
7	2	Minus
8	6	
9	3	
10	3	
11	No Pin	
12	No Pin	
13	0	
14	Internal Conn.	Internal Conn.

PIN NUMBER	CHARACTER
1	7
2	5
3	8
4	Anode
5	1
6	4
7	2
8	6
9	3
10	3
11	Decimal Pt.
12	No Pin
13	0
14	Internal Conn.

PIN NUMBER	CHARACTER
1	Internal Conn.
2	Even Anode
3	8 and 9
4	6 and 7
5	4 and 5
6	Screen
7	2 and 3
8	and 1
9	Odd Anode

*Other characters available by special order

**See Fig. 1 & 3, Page 7. Use of the highest voltage available with the appropriate resistor is recommended.

GENERAL

A National Readout Tube is basically a gas filled, cold cathode diode with multiple cathodes. Each cathode is shaped like a display character and has a separate base pin electrical connection. Negative voltage (with respect to anode) applied to the selected character base pin causes the shaped glow discharge.

Readout Tube operation can be explained more fully by considering the tube similar to a single cathode gas diode. Fig. 1 shows a simple operating circuit with the Readout Tube

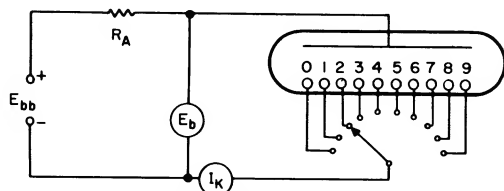


FIG. 1. READOUT TUBE FUNDAMENTAL CIRCUIT

diode-connected as in normal use. By varying circuit parameters, we can obtain a typical plot (Fig. 2) of tube voltage, E_b , versus cathode current, I_k . Increasing E_b from zero to the ionization voltage causes only a small increase in I_k and no glow. At ionization voltage, a glow appears. With increasing I_k , two glow regions are reached; normal and abnormal. For clarity in this discussion, the high current end of abnormal glow is called intense glow. Normal glow illuminates only partial characters so is not satisfactory; intense glow operation will shorten tube life. Desired operation is obtained in the abnormal glow region and is the operating condition specified in technical data sheets.

ELECTRICAL RATINGS AND CHARACTERISTICS

Ionization Voltage (Maximum)

All tubes will operate properly at or above the Maximum Ionization Voltage. Ionization will occur in all cases at less than maximum specified voltage but a higher value is required to assure uniform operation between tubes. This is discussed at greater length under Recommended Operating Conditions.

Supply Voltage, E_{bb} (Minimum)

Minimum Supply Voltage must always equal or exceed Maximum Ionization Voltage for proper tube operation. This is a necessary condition to make sure that all tubes will ionize and operate within rated current limits. How Supply Voltage in conjunction with anode resistance determines cathode current is explained under Recommended Operating Conditions.

Cathode Current, I_k — Peak (Maximum)

Cathode Current, as shown in Fig. 2, determines in which glow region the tube operates. Maximum Peak Cathode Current places operation at the higher end of abnormal glow approaching the region of intense glow with attendant shortened life. This, then, represents the maximum peak current for long life.

Cathode Current, I_k — Average (Maximum and Minimum)

Again referring to Fig. 2, maximum and minimum limits of cathode current keep tube operation within the abnormal glow region giving the best display consistent with long life. Optimum current is midway between maximum and minimum.

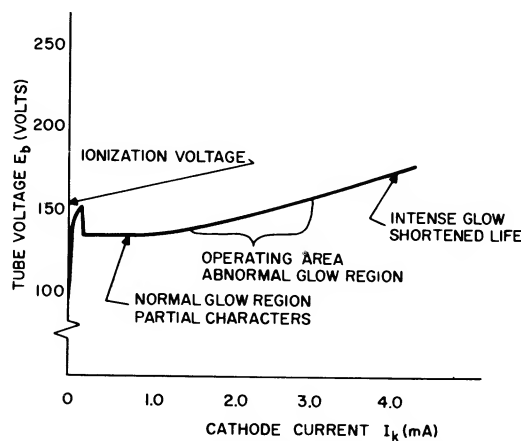


FIG. 2. NL-8421 TYPICAL VOLT-AMPERE CHARACTERISTIC

Recommended Operating Conditions

Various Supply Voltages (E_{bb}) are given with corresponding values of anode resistor (R_A) for proper operation. These values are obtained from an electrical characteristic curve, Fig. 3. The NL-8421 is used as an example; other tube types have similar curves. Two parallel lines show characteristic limits for all tubes of one type. Load lines are drawn for different values of R_A by first selecting a supply voltage, for example, 170 volts. A line drawn from this voltage on the ordinate through the intersection of mean I_k and a point midway between the parallel characteristic limits, has a slope representing proper R_A , in this case, 10K ohms. By identical steps, R_A is found for each E_{bb} of interest.

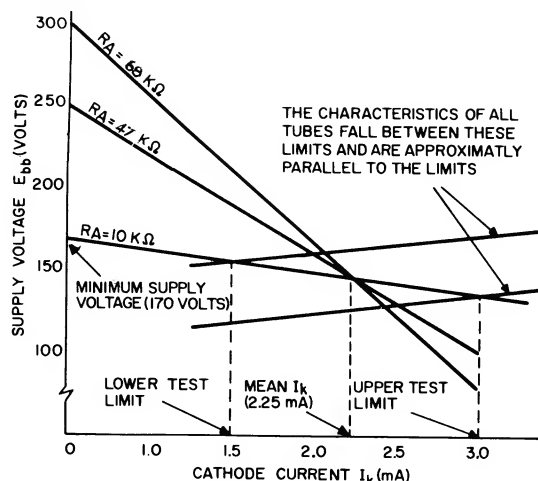


FIG. 3. ELECTRICAL CHARACTERISTICS

All tubes in circuits with a particular load line will operate on that line somewhere between the parallel characteristic limits. For example, at E_{bb} of 170 volts and R_k of 10K ohms, all tubes will operate between 1.5 ma (lower test limit) and 3.0 ma (upper test limit). Each load line has a different length between the parallel characteristic limits. This means that cathode current extremes are different for each load line.

What are limits on load lines? If a load line is drawn from a supply voltage of less than 170 volts, cathode current can range outside of specified limits giving partial characters if current is low and short life if high. As E_{bb} and R_A are increased, tubes operate within a narrower cathode current range. This is desirable as it reduces any glow variation between tubes. For most NL-8421 applications, an E_{bb} of 170 and R_A of 10K ohms is satisfactory. When necessary, higher values can be used.

Anode resistance values for higher anode voltages can be calculated using the following equation:

$$R_a = \frac{E_{bb} - E_{td}}{I_k}$$

R_a —Anode resistance in ohms.
 E_{bb} —Supply voltage volts.
 I_k —Average cathode current.
 E_{td} —Voltage drop across tube at average current.

The average current and the corresponding tube drop are listed below:

Tube Type	E_{td} Volts	I_k (avg) ma
NL-7094	150	5.5
NL-7037	135	8.0
NL-8091	145	4.75
NL-8423	147	3.0
NL-7153	143	2.5
NL-6844A	135	2.25
NL-8037	147	2.25
NL-8421	147	2.25
NL-8422	150	2.25
NL-803	150	2.25
NL-809	150	2.50
NL-807	150	3.12
NL-5030	142	3.8
NL-7977	154	1.05
NL-7009	102	0.95
NL-4021	102	1.05

PREBIAS VOLTAGE

Pre-Bias Voltage is a potential difference applied between "on" and "off" cathodes. Without pre-biasing, a signal voltage amplitude equal to Minimum Supply Voltage is needed to switch "on" a character. Pre-biasing permits a smaller signal to be used. This is particularly useful with semiconductor switching circuits.

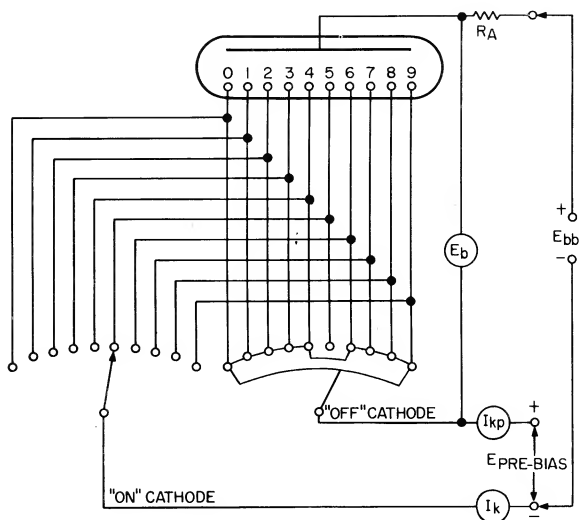


FIG. 4. BASIC READOUT TUBE PRE-BIAS CIRCUIT

The basic Readout Tube pre-bias circuit is shown in Fig. 4. Pre-bias voltage, $E_{PRE-BIAS}$, is varied while measuring "off" cathode pre-bias current, I_{kp} , giving the curves in Fig. 5. E_{bb} is varied only as necessary to keep I_k constant at 2.25 ma. The two curves represent spread of pre-bias current resulting from different distances between "on" and "off" cathodes. For example, in a numerical Readout Tube, the distance between cathode "3" and "1" is different than that between "3" and "4". With "3" as the "off" cathode, there will be different pre-bias current depending upon whether "1" or "4" is the "on" cathode.

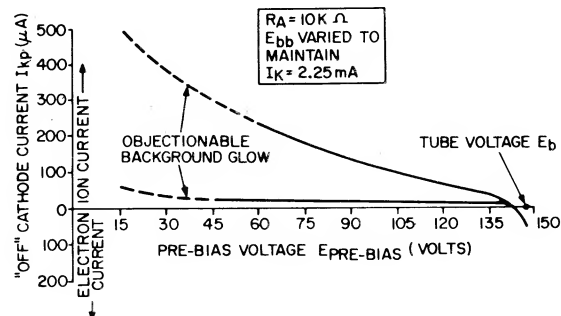


FIG. 5. PRE-BIAS VOLTAGE VS "OFF" CATHODE CURRENT FOR NL-8421 READOUT TUBE

Pre-bias current is important because it affects tube operation. Referring to Figures 4 and 5, when $E_{PRE-BIAS}$ is greater than tube voltage, E_b , the "off" cathode will take over as an anode and accept electron current. "On" cathode current would no longer be limited by R_a , causing loss of control. When $E_{PRE-BIAS}$ is less than E_b , the "off" cathode will accept ionization current. As $E_{PRE-BIAS}$ is reduced, I_{kp} increases, finally causing "off" cathode ionization and background haze. The lower limit of $E_{PRE-BIAS}$ is determined by objectionable background haze, the upper limit by the lowest tube voltage expected. Typical pre-bias voltage limits (NL-8421, for example) are 50 V to 120 V.

BIQUINARY CHARACTERISTICS

The Biquinary Readout tube is similar to the decimal or 10 line Readout tube. However, biquinary tube design permits the tube to be driven directly by a 2-5 or biquinary code. This is accomplished by dividing the tube into two electrical compartments separated by a transparent screen. (Figure S-337). The front compartment contains cathodes 1, 3, 5, 7, 9 and the odd anode. The rear compartment contains cathodes 0, 2, 4, 6, 8 and the even anode. Cathodes are connected internally in pairs 0 and 1, 2 and 3, 4 and 5, 6 and 7, 8 and 9 and a lead from each pair is connected to a base pin. By energizing the appropriate base pin and anode, a particular cathode can be caused to glow and display the desired character.

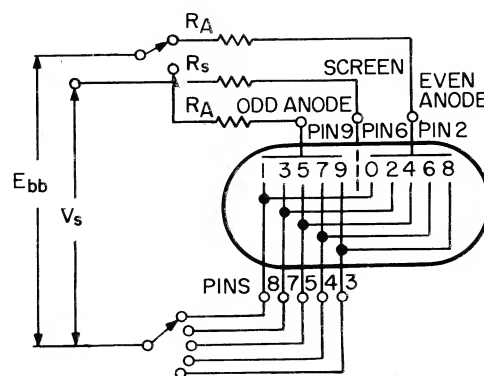


FIG. 6 FUNDAMENTAL BIQUINARY TUBE CIRCUIT

CIRCUITS AND APPLICATIONS

GENERAL

Electronic Readout Tubes have manifold uses whenever information from electronic or electro-mechanical circuits has to be displayed. Typical examples are counting instruments—frequency, neutron, gamma radiation; information displays—stock quotation, airport flight information; digital readout replacing meters—voltmeters, flowmeters; many others from digital clocks to teaching machines. Each application has its own conditions involving type of signal available, ambient lighting, size and space of display. Information is provided here to help apply Readout Tubes.

DRIVER CIRCUITS

An electro-mechanical stepping switch using circuits similar to Figure 1 is the simplest method of driving Readout tubes, but slow speed and high cost limit usage. Semi conductor driving circuits using NPN transistors or similar semi conductor devices are more widely used. Typical transistor driving circuits are shown in Figure 7.

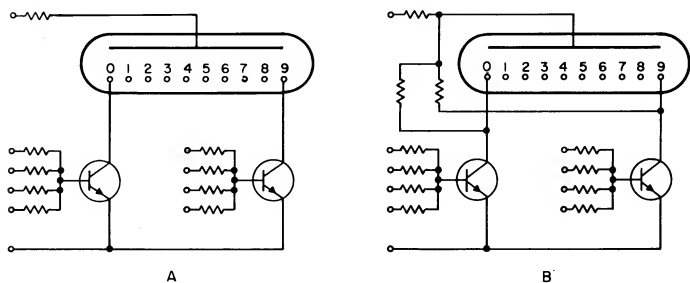


FIG. 7 TYPICAL TRANSISTOR CIRCUITS

In normal operation the "on" transistor is operated in saturation and the "off" transistor is operated in a back bias state. These "off" transistors will carry some collector leakage current. If this leakage current becomes excessive, a background glow or haze can be observed in the Readout tube. As explained in the section on Pre-bias Voltage, the total "off" cathode current should be kept below 100uA and the "off" cathode voltage should be above 50 volts. To allow some margin, a driver transistor should have a maximum collector leakage current of 1.0uA at 65 volts and 25°C and a maximum of 10uA at 85°C. Transistors with higher leakage currents can be used by connecting the collector to a source of high positive voltage. Normally a 1.5 megohm resistor is connected from each collector to the anode as shown in Figure 7 B. Some transistors suitable for driving Readout tubes are:

Silicon:

Texas Instrument	TI 496
RCA	40346
Fairchild Semi conductor	2N 1990

Germanium:

General Transistor	2N 1310
	2N 1311

A widely applied and economical decoder driver circuit is shown in figure 8. The decoder accepts a BCD input and decodes to a biquinary signal. The decoded signal selects one of five pairs of odd-even characters. The odd-even selection is then made by the presence or absence of a 1 in the input BCD signal.

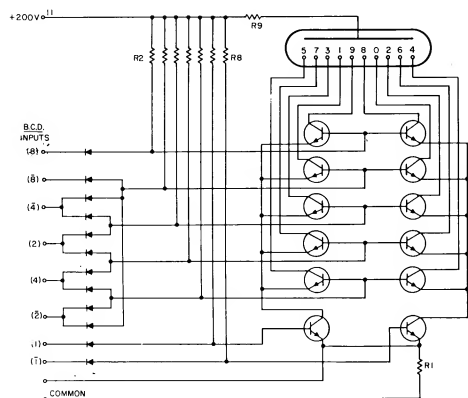


FIG. 8 DECODER DRIVER CIRCUIT

The BCD to decimal character display translation is shown in truth table below. Logic 1 level is more positive than logic 0. Codes other than the 8, 4, 2, 1 BCD can be accommodated by changing the interconnection between the decoder diodes.

DISPLAYED CHARACTER

BCD INPUT	0	1	2	3	4	5	6	7	8	9
1	0	1	0	1	0	1	0	1	0	1
$\overline{1}$	1	0	1	0	1	0	1	0	1	0
2	0	0	1	1	0	0	1	1	0	0
$\overline{2}$	1	1	0	0	1	1	0	0	1	1
4	0	0	0	0	1	1	1	1	0	0
$\overline{4}$	1	1	1	1	0	0	0	0	1	1
8	0	0	0	0	0	0	0	0	1	1
$\overline{8}$	1	1	1	1	1	1	1	1	0	0

The decoder can be driven directly from a standard 4 binary decimal counter with a 3 volt or greater output swing to give a full decade counting and display unit.

An alternate decade counting circuit for relatively slow counting speeds utilizing a minimum of components, can be made using silicon controlled switches in a ring counting circuit. The counter will count and store at maximum pulse rate of 5 KCS. Reset can be accomplished by several different methods. One method opens the +12 volt dc supply; another method opens the common scs ground.

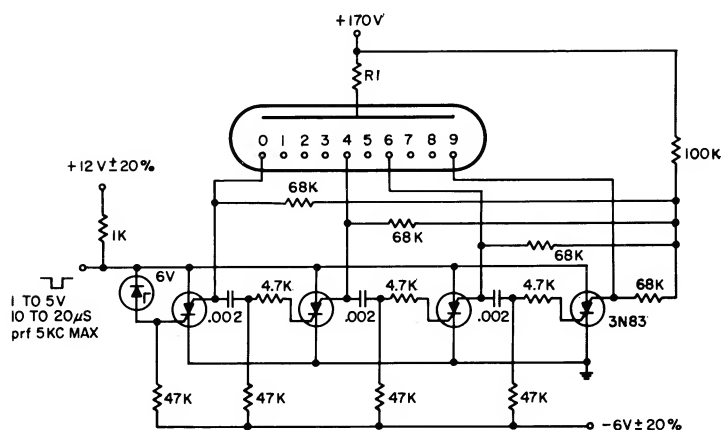


FIG. 9 SCS RING COUNTER

DIMMING

When Readout Tube intensity is too great, as when used in low ambient light applications, dimming can be done by suitable circuits. Just reducing tube current will not work as glow remains quite constant over the normal current range. A practical method is to switch the tube on and off at a rate slow enough to provide dimming but not so slow as to cause visible flicker.

A free running multivibrator in the Readout Tube plate circuit is a low cost dimming method. Multivibrator output is fed into a cathode follower for a low impedance match to the Readout Tube or tubes. Suggested output pulse for this dimmer is 200 volts amplitude (positive) and 100 microseconds duration with a variable repetition rate.

MOUNTING AND PACKAGING

Display effectiveness, primarily dependent upon the Readout Tube, is improved by well designed packaging. In practically all applications, mount the tube inside an enclosure painted dull black to minimize reflections from external light sources and internal tube glow. An ordinary red or amber plastic filter or a circular polarizing one will correct reflection troubles from a high ambient light level. Filtering reduces reflections from both the tube glass surface and the internal characters improving contrast and readability. Red and amber filters work well because

they match the neon glow and also eliminate the bluish haze characteristic of ultra long life tubes. Polaroid filters are probably the most frequently used polarizing types and work particularly well in high ambient conditions.

Filter density is not critical but should be considered in relation to the amount of ambient light expected. Relatively dense filters are used in subdued light applications, for example, radar rooms.

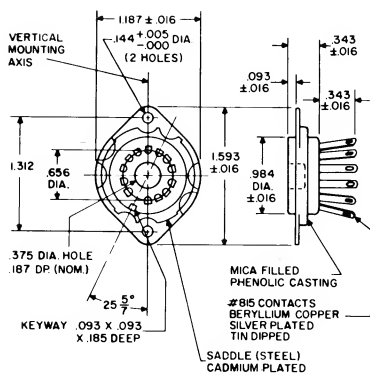


Bezel assemblies complete with enclosure, sockets and Polaroid filter are available.

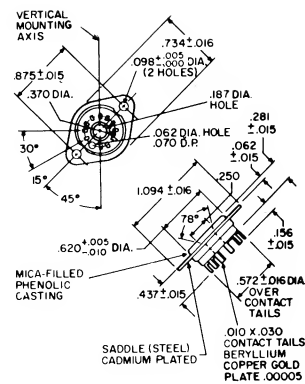
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READOUT TUBE SOCKETS

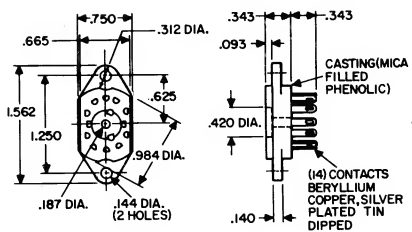
RTS-1, RTS-2



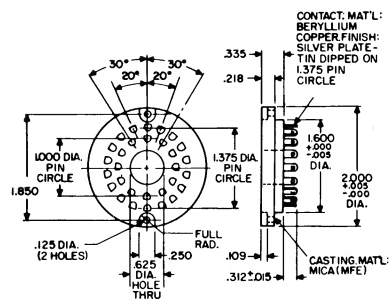
RTS-3



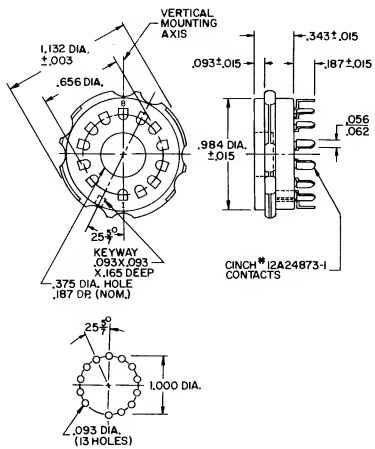
RTS-4



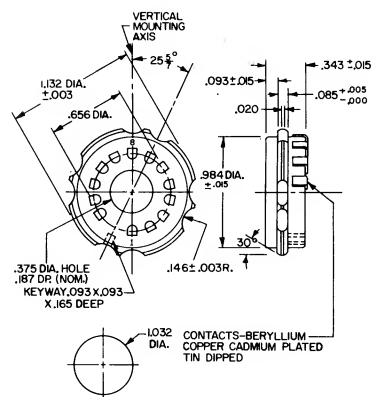
RTS-5



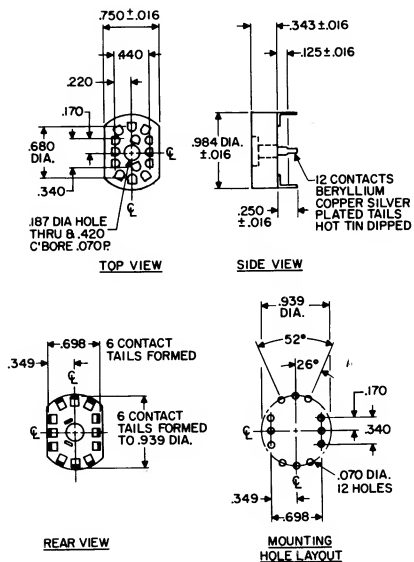
RTS -6, RTS -8



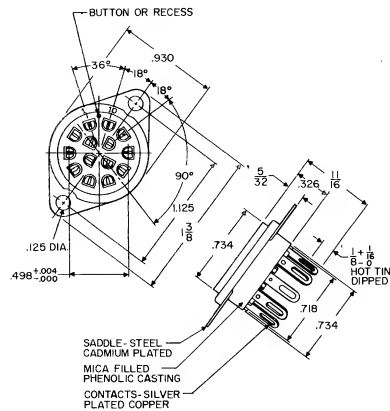
RTS-9



RTS-10



RTS-11



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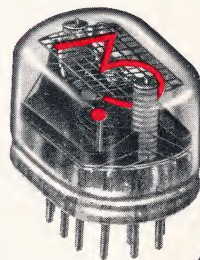
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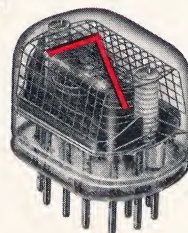
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	NL-4031	Long Life (\pm)
	NL-7009	Standard Life (0-9)
	NL-7977/4032	Long Life (0-9)
	NL-8502/4021	Standard Life, Low Voltage (0-9)
Standard 0.6" Characters	NL-803	Side View, Long Life (0-9)
	NL-809	NL-8422/5991 with decimal
	NL-5016	Standard Life (\pm)
	NL-5030	Side View, Long Life, Biquinary (0-9)
	NL-5032	Long Life (\pm)
	NL-5992	Long Life, Rectangular (\pm)
	NL-6844A	Standard Life (0-9)
	NL-8037/5031	Long Life (0-9)
	NL-8421/5092	Long Life, Wide Angle (0-9)
	NL-8422/5991	Long Life, Rectangular (0-9)
	NL-50911	Long Life, Wide Angle (\pm)
Super 0.8" Characters	NL-6012	Standard Life (\pm)
	NL-6034	Long Life (\pm)
	NL-7153	Standard Life (0-9)
	NL-8423/6091	Long Life, Wide Angle (0-9)
Large 1.375" Characters	NL-8091	Long Life, Wide Angle (0-9)
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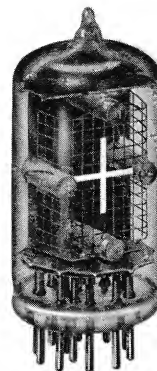
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161 Washington St.

Metropolitan Supply Co.
443 Park Ave. South

State Labs, Inc.
215 Park Ave. South

Terminal-Hudson
236 West 17th St.

Rochester
Rochester Radio Supply
140 W. Main St.

Rome
Rome Electronics
108 Spring St.

NORTH CAROLINA

Raleigh
Southeastern Radio Supply
414 Hillsboro St.

Winston-Salem
Kirkman Electronics, Inc.
823 S. Marshall

OHIO

Akron
Akron Electronic Supply Co.
107-117 S. Arlington

Canton
Burrroughs Amiet Electronics
2705 Fulton Rd., N.W.

Cincinnati
Newark-Herrlinger Distr.
112 E. Liberty St.

Cleveland
Pioneer-Standard Electronics
Pioneer Division
5403 Prospect Ave.

Radio & Electronic Parts Co.
3235 Prospect Ave.

Columbus
Hughes-Peters, Inc.
481 E. 11th St.

Dayton
John A. Becker Co.
14 Brown St.

Pioneer-Standard Electronics
Srepco Div.
314 Leo St.

Stotts-Friedman Co.
108 N. Jefferson St.

Lima
Lima Radio Parts Co.
600 N. Main St.

Warren
D & J Electronic Supply
207 Elm St., S.E.

OKLAHOMA

Oklahoma City
Radio, Inc.
903 N. Hudson

Trice Wholesale Electronics
4701 N. Stiles

Tulsa
Oil Capitol Electronics
708 S. Sheridan, Box 5423

Radio, Inc.
1000 S. Main St.

OREGON

Portland
(Also cover Salem, Eugene & Medford)

United Radio Supply
22 N.W. 9th Ave.

NATIONAL ELECTRONICS, INC.

A SUBSIDIARY OF VARIAN ASSOCIATES
GENEVA, ILLINOIS, U. S. A.

PHONE (312) 282-4300

DISTRIBUTORS STOCKING NATIONAL® READOUT TUBES

PENNSYLVANIA

Allentown
A. A. Peters, Inc.
231 N. 7th

Boston
Barno Radio
Smithfield & Yates

Philadelphia
Radio Electric Service of Pa.
701 Arch St.

Pittsburgh
Cameradio Co.
1121 Penn Ave.

Reading
Geo. D. Barbey Co., Inc.
333 N. 4th St.

RHODE ISLAND

Providence
Wm. Dandreta Co.
28 Wolcott St.

SOUTH CAROLINA

Charleston
Radio Laboratories
475 E. Bay St.

Greenville
Carolina Radio Supply Co.
1221 W. Washington St.

TENNESSEE

Knoxville
Chemcity Radio & Electric
2211 Dutch Valley

TEXAS

Dallas
Wilkinson Bros.
2408 Ross Ave.

Houston
Busacker Electronic Equipment Co.
1216 Clay St.

Geophysical Supply Co.
1500 Crawford

UTAH

Salt Lake City
S. R. Ross, Inc.
1212 S. State St.

Standard Supply Co.
225 E. 6th S.

VIRGINIA

Norfolk
Radio Parts Distr. Co.
128 W. Olney Rd.

Richmond
Meridian Electronics
1001 W. Broad St.

WASHINGTON

Bellingham
Advance Electronics
804 Du Pont

Everett
Pringle Electronics
2101 Colby

Seattle
Allied Radio
1020 4th Ave., S.

Robert E. Priebe Co.
2228 2nd Ave.

Seattle Radio Supply
2117 2nd Ave.

Spokane
Northwest Electronics
E 730 1st Ave.

WISCONSIN

Milwaukee
Radio Parts, Inc.
1314 N. 7th St.

Oshkosh
Electronic Industries
19 E. Irving Ave.

West Allis
Marsh Radio Supply Co.
6047 W. Beloit Rd.

CANADA

BRITISH COLUMBIA

Vancouver
L. A. Varah, Ltd.
1250 W. 6th Ave.

ONTARIO

Toronto
Zentronics Ltd.
66 Orfus Rd.

QUEBEC

Montreal
Payette Radio Ltd.
730 St. James St., W.

NATIONAL ELECTRONICS, INC.

A SUBSIDIARY OF VARIAN ASSOCIATES

GENEVA, ILLINOIS, U. S. A.

PHONE (312) 232-4300

[N] New Types Added

↓ Price Reduction

↑ Price Increase

PRICES

NATIONAL READOUT TUBES AND SOCKETS

Effective Date
Oct. 25, 1965
Cancels Price Sheet
August 16, 1965

National Type No.	Class	QUANTITY	1-99	100-499	500-999	1000-4999
Miniature — 0.3" Numeral Height						
NL-4022	Standard Life (±)	19.00	17.00	15.00	13.25	
NL-4026	Standard Life, Low Voltage (±)	33.00	28.00	24.00	20.00	
NL-4031	Long Life (±)	33.00	28.00	24.00	20.00	
NL-7009	Standard Life (0-9)	19.00	17.00	15.00	13.25	
NL-7009A*	Standard Life (0-9) tested for dark ionization	20.90	18.70	16.50	14.55	
NL-7977/4032	Long Life (0-9)	33.00	28.00	24.00	20.00	
NL-7977A*	Long Life (0-9) tested for dark ionization	36.30	30.80	26.40	22.00	
NL-8502/4021	Standard Life, Low Voltage (0-9)	33.00	28.00	24.00	20.00	
Standard — 0.6" Numeral Height						
↓ NL-803	Side View, Long Life (0-9)	9.50	8.50	7.50	6.50	
NL-809	Long Life, Rectangular with decimal point (0-9)	17.35	14.75	12.10	9.65	
[N] NL-811	Side View, Long Life (±)	9.50	8.50	7.50	7.50	
[N] NL-812	Side View, Long Life with decimal point (0-9)	10.00	9.00	8.00	7.00	
NL-5016	Standard Life (±)	11.00	9.70	8.80	8.00	
NL-5030	Side View, Long Life, Biquinary (0-9)	10.50	9.30	8.30		
NL-5032	Long Life (±)	15.75	13.40	11.00	8.75	
NL-5035	Long Life (L to X less O, Q, U)	49.00	35.00	21.00	18.90	
NL-5961	Non Mercury Rectangular (0-9)	17.35	14.75	12.10	9.65	
NL-5992	Long Life, Rectangular (±)	15.75	13.40	11.00	8.75	
NL-6844A	Standard Life (0-9)	11.00	9.70	8.80	8.00	
NL-8037/5031	Long Life (0-9)	15.75	13.40	11.00	8.75	
NL-8421/5092	Long Life, Wide Angle (0-9)	15.75	13.40	11.00	8.75	
NL-8422/5991	Long Life, Rectangular (0-9)	15.75	13.40	11.00	8.75	
NL-50322	Long Life (A to K less I)	49.00	35.00	21.00	18.90	
NL-50911	Long Life, Wide Angle (±)	15.75	13.40	11.00	8.75	
Super — 0.8" Numeral Height						
[N] NL-807	Side View, Long Life (0-9)	10.00	9.00	8.00	7.00	
NL-6012	Standard Life (±)	14.50	12.25	10.40		
NL-6034	Long Life (±)	20.00	17.00	15.00		
NL-7153	Standard Life (0-9)	14.50	12.25	10.40		
NL-8423/6091	Long Life, Wide Angle (0-9)	19.00	16.00	14.35		
Large — 1.375" Numeral Height						
↓ NL-8091	Long Life, Wide Angle (0-9)	22.50	16.90	16.90	16.90	
Jumbo — 2.0" Numeral Height						
NL-7037	Long Life, Side View (0-9)	26.50	19.00	19.00	19.00	
↓ NL-7094	Long Life, Wide Angle (0-9)	30.00	22.50	22.50	22.50	
National Position Indicator Tubes						
NL-9012	Long Life (0-9)	5.00	5.00	5.00	4.75	

*Indicates types containing radioactive gas for improved dark ionization. All other tube types are available with radioactive gas at 10% additional charge.

For socket prices see other side of sheet.

OTHER COMBINATIONS OF CHARACTERS ARE AVAILABLE ON SPECIAL ORDER

NATIONAL ELECTRONICS, INC.

A SUBSIDIARY OF VARIAN ASSOCIATES

GENEVA, ILLINOIS

SOCKETS

National Type No.	Replaces	Class	QUANTITY	1-99	100-499	500-999	1000-4999
RTS-1	SK-112	For NL-5016, NL-5032, NL-6012, NL-6034, NL-6844A, NL-7153, NL-8037/5031, NL-8421/5092, NL-8423/6091, NL-50911, Mil. Spec. Material		.90	.65	.55	.45
RTS-2	SK-120	Same As RTS-1 Except Commercial Grade Material		.75	.50	.40	.30
RTS-3	SK-116A	For NL-4022, NL-4026, NL-4031, NL-7009, NL-7977/4032, NL-8502/4021		1.00	.85	.75	.65
RTS-4	SK-136 SK-169	For NL-809, NL-5992, NL-8422/5991		.90	.65	.55	.45
RST-5	SK-137	For NL-7037, NL-7094, NL-8091		1.25	1.10	.90	.80
RTS-6	SK-135	Same As RTS-1 Except Printed Circuit, Standoff, Commercial Grade Material		.85	.55	.45	.35
RTS-7 (H&V)	SK-111	For NL-9012		1.25	1.10	.90	.80
RTS-8	SK-125	Same as RTS-1 Except Printed Circuit, Standoff Type		.90	.65	.55	.45
RTS-9	SK-109	Same as RTS-1 Except Printed Circuit, Butt Type		.90	.65	.55	.45
RTS-10	SK-144	Same as RTS-4 Except Printed Circuit Standoff Type		.90	.65	.55	.45
RTS-11		For NL-803, NL-807, NL-811, NL-812		.40	.35	.30	.25
N RTS-12		Same as RTS-11 Except Printed Circuit, Standoff Type		.40	.35	.30	.25

PRICES — All prices subject to change without notice.

TERMS — All invoices are net 30 days. Partial shipments will be billed and payments will be due in accordance with these terms.

TRANSPORTATION — All shipments are F.O.B. points of shipment.

SPECIAL PACKING — Any special packing other than National Electronics standard commercial domestic packing will be billed in accordance with the requirements.

TAXES — Federal, state, or local excise, sales, and/or similar taxes are not included in these prices.

PATENT LIABILITY — National Electronics, Inc. is not liable for any patent infringements resulting from the use or application of any electron tube, or any device, offered or sold by National Electronics, Inc.

WARRANTY

LONG LIFE READOUT tubes are warranted to be free from defects caused by materials, workmanship, and construction for a period of two years from the date of shipment. Standard Life readout tubes are warranted to be free from defects caused by materials, workmanship and construction for a period of 90 days from date of shipment. National Electronics, Inc. liability under this warranty is limited to replacing or repairing any tube returned by the buyer during such period provided:

1. Buyer promptly notifies National Electronics, Inc., Geneva, Illinois in writing requesting authorization to return the tube as per our warranty policy. Letters should itemize complaints.
2. The defective unit is returned to address in (1), transportation charges prepaid.
3. Manufacturer's examination shall disclose to its satisfaction that defects have not been caused by misuse, neglect, accident or improper installation.

Under no conditions shall National Electronics, Inc. be liable for collateral or consequential damages. The warranty is in lieu of all other warranties expressed or implied.